Affinity Water

AFW103 Connect 2050 supply interconnector modelling critique

Review of Ofwat's supply interconnectors model

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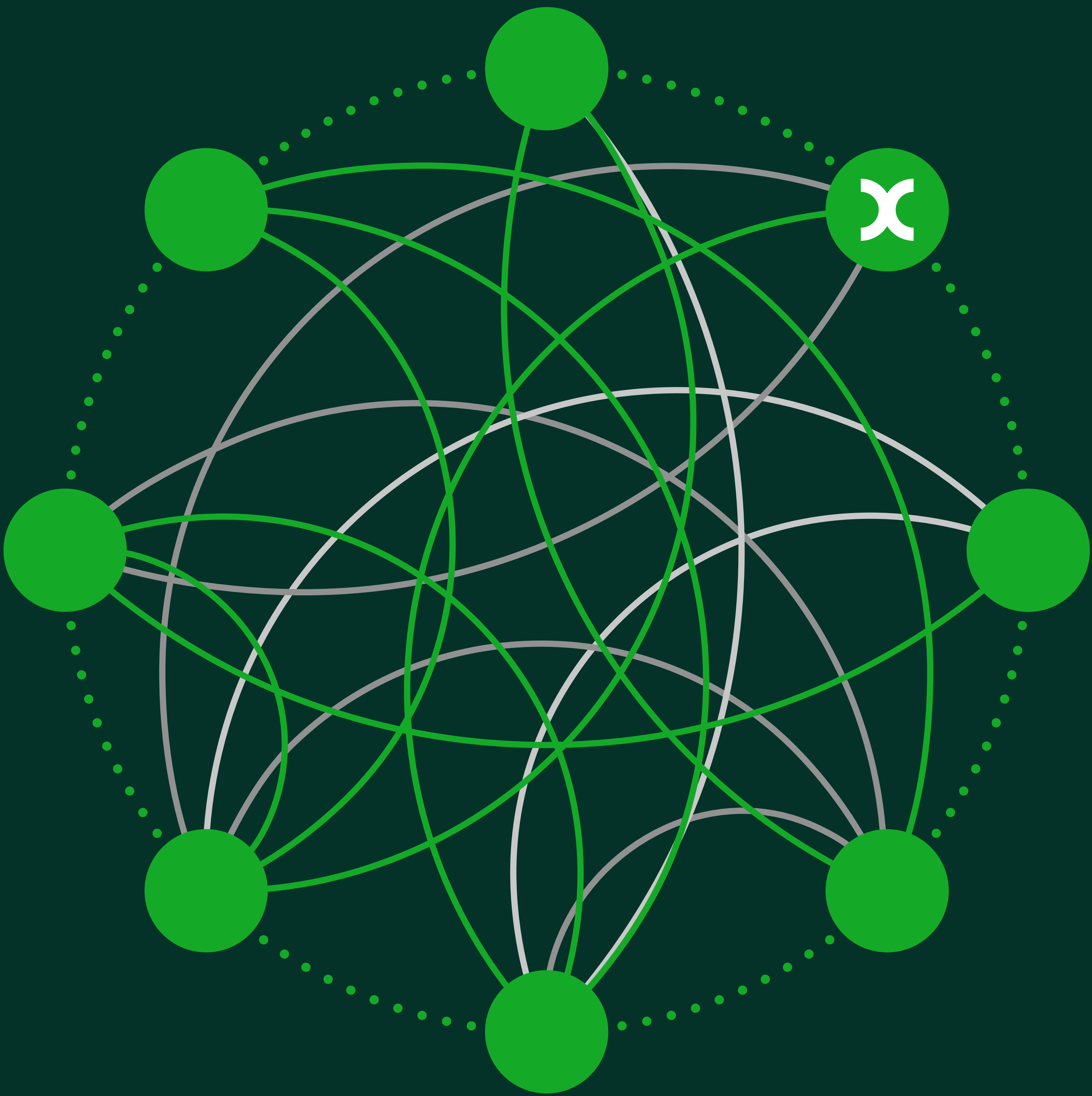

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Review of Ofwat's supply interconnectors model

Introduction

Supply interconnectors provide a supply–demand benefit to customers by joining two or more water resource zones and transferring water between them. Interconnector schemes can be complex due to the positions and physical characteristics of the zones being connected. In the PR24 business plans, water companies have set out their proposed costs for a range of interconnector schemes, some of which will be delivered over multiple asset management periods (AMPs). Affinity Water (AFW) has developed its interconnector schemes as part of its Connect 2050 programme of works.[1]

To assess companies' proposals for the interconnector schemes, Ofwat has developed scheme-level econometric cost models using two cost drivers (length and benefit) applied on historical and forecast data. To determine the cost allowances, results from historical and forecast data are triangulated after a bias correction,[2] and the scheme-level results of the supply interconnectors alone are aggregated to the company level. Ofwat reallocates the non-supply interconnector schemes (such as resilience) to corresponding enhancement categories for further assessment.[3] Applying an average benchmark to the company-level results, Ofwat concludes that AFW's allowance for its supply interconnector scheme (Egham and Iver) should be £42.5m against a requested cost of £68.6m.[4]

We have the following two main criticisms of Ofwat's approach.

1 Ofwat does not use the same set of schemes in the model estimation approach and in subsequent steps (i.e. aggregation, bias correction, triangulation and benchmark estimation). The

[1] See Appendix A1 for a more detailed description of AFW's Connect 2050 programme, including the specific interconnector projects that are captured in Ofwat's cost modelling.
[2] As Ofwat models the scheme-level data in logarithms, transforming the results back into levels results in a significant bias at the scheme level: see Ofwat (2019), 'PR19 final determinations: Delivering outcomes for customers policy appendix', December, pp. 93–94 and 105–106. Ofwat corrects for this log transformation bias by applying an adjustment to the predicted costs equal to the ratio of submitted costs to predicted costs at the industry level.
[3] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', July. At PR19, Ofwat relied on business plan forecasts and used a combination of deep dives, shallow dives and unit cost assessments of supply interconnectors and other interconnector schemes across companies: Ofwat (2019), 'PR19 final determinations: Securing cost efficiency technical appendix', December.
[4] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', July, Table 29.

resulting inconsistencies are unexplained and result in a material bias in Ofwat's assessment for AFW. Correcting for these errors and adopting a consistent methodology results in AFW's programme of interconnector schemes being deemed efficient.

2 Ofwat has not robustly investigated the reliability of its analysis or considered necessary normalisations, given the overly simple models that it has employed. Specifically, there are several clear indicators of the complexity of AFW's 'Egham and Iver' scheme (including pipe diameter, terrain features such as surface type, urbanity, and number of major rail/road crossings to be managed) that are not correlated with (i.e. not captured by) the drivers considered in Ofwat's model. Normalising for these complexities and modelling AFW's normalised scheme using Ofwat's models results in it being deemed efficient. This demonstrates that Ofwat should be cautious[5] in relying solely on simple cost models to determine cost allowances, and that it should consider appropriate normalisation and robust post-modelling procedures (such as deep dive assessments) for more complex schemes such as Egham and Iver.

Overview of Ofwat's approach

In its econometric analysis, Ofwat uses relevant interconnector schemes that are part of a company's water resources management plan (WRMP).[6] These comprise supply, resilience, water framework directive (WFD) and Direct Procurement for Customers (DPC) interconnector schemes that have been proposed by companies to meet new statutory obligations, improve resilience, or address drought conditions. Ofwat has deemed the pipeline elements of these different types of scheme to be comparable, and has included them in its analysis. There are 23 schemes in the (historical) PR19 regulatory period,[7] and 32 proposed (forecast) schemes in the PR24 regulatory period. For AFW, the forecast data covers four interconnector projects included in its Connect 2050 project—i.e. three WFD projects plus the

[5] Ofwat sets an average benchmark when assessing these costs, although it states that it will consider setting a more stringent benchmark at the final determination (FD). In the current context—where complex schemes with many cost drivers are benchmarked against each other using a simple model—even an average benchmark may result in an overly stringent efficiency challenge for some schemes/companies.
[6] It does not include intra-zonal schemes or scheme that did not meet enhancement investment criteria. See Ofwat (2024), 'PR24 Draft Determinations: Expenditure allowances – Enhancement cost modelling appendix', July, p. 74.
[7] Here, the relationship between costs and cost drivers is estimated using historical data, and this relationship is extrapolated for new schemes in AMP8. This is broadly in line with Ofwat's approach to modelling base expenditure.

Egham and Iver supply interconnector scheme (this project is explained in more detail in Appendix A1).

Ofwat estimates separate regressions on the two datasets (historical and forecast) at the scheme level, with the total expenditure (TOTEX) of the scheme as the dependent variable, and benefit (i.e. water available for use) and length (of the scheme) as the cost drivers.

Ofwat aggregates the results from its modelling for the supply interconnector schemes alone at the company level, combining the results from the two regressions in the process after separate bias corrections. For the PR24 forecast data, Ofwat includes only 18 of the 32 schemes used in the underlying regression analysis. In the case of AFW, only one of its four schemes (Egham and Iver) included in the regression analysis is considered in subsequent steps. Moreover, Ofwat considers the TOTEX that companies are planning to incur in AMP8 alone (rather than the full TOTEX considered in its modelling) in determining the company-specific efficiencies, bias correction, average benchmark and company-level allowances.

For reference, we summarise Ofwat's modelling approach in the following six steps.

1. An econometric cost model is developed, with the full TOTEX of the interconnector scheme as the dependent variable, and benefit and length as the cost drivers.
2. This model is estimated on two samples of interconnector schemes (historical (PR19) and forecast (PR24) samples).
3. Scheme-level predictions are aggregated to the company level in the two periods. For the forecast period, Ofwat assesses only 18 supply interconnector schemes out of the 32 total schemes, with corrections to the submitted and predicted TOTEX based on companies' proposed spend in AMP8.
4. The bias correction is estimated for the historical and forecast periods separately.
5. For each company, predicted allowances (after bias correction) for its PR24 supply interconnector schemes from the historical and forecast models are triangulated using equal weighting.
6. The company-level efficiency for the PR24 supply interconnectors is calculated as the ratio of requested TOTEX for AMP8 to the predicted company-level allowance.

Inconsistent treatment of interconnector schemes and recommendations

The inconsistencies in Ofwat's approach are due to the following reasons:

- dropping all but the supply interconnector schemes when aggregating the results to the company level;
- adjusting submitted TOTEX to spend in AMP8 when estimating company-specific efficiency;
- incorrectly implementing the bias correction on the reduced sample and adjusted TOTEX.

We address these issues in turn below.

Inconsistent consideration of the interconnector schemes

Ofwat considers that the different types of interconnector scheme (supply, WFD, DPC and resilience) are sufficiently comparable to be included in the same model. Specifically, Ofwat's modelling assumes that these different types of scheme have the same cost drivers (namely, length and benefit), that these cost drivers influence the costs of each type of scheme in the same way, and that there are no other drivers of costs that may be relevant. Ofwat states that it has explored additional drivers, such as diameter of pipeline and pumping capacity, but that these did not lead to an improvement in model performance.[8] Ofwat noted in its report that it also performed outlier analysis,[9] but concluded that no schemes should be excluded.

Ofwat's econometric model is simple, with only two high-level cost drivers. Notably, the model does not account for physical, operational or engineering challenges facing specific interconnector schemes. Project-specific factors that are expected to influence costs—such as pipeline material, design complexity, terrain features, and technological requirements—are not fully reflected in Ofwat's model. Schemes of different types are likely to differ along these dimensions, and these differences are likely to be misattributed to (in)efficiency for affected schemes. The heterogeneity across the schemes is evident from the wide range of efficiency scores at the scheme level (c. 29–245%)—we

[8] See Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', July, p. 76.
[9] In Ofwat's Draft Determination (DD) documentation, it states that it has undertaken a deep-dive assessment of outlier schemes. However, we understand from a response to a query shared by AFW that this is not the case and that there are no post-modelling adjustments.

consider that it is unrealistic that one scheme should be c. eight times less efficient than another.

Indeed, even if one assumes that a *company* can be eight times less efficient than another, the range of estimated efficiency scores for schemes *within* a company is infeasibly wide. For example, the forecast unadjusted efficiency of AFW's schemes ranges from 40.08% to 201.35%. If the models were detecting managerial (in)efficiency, we would expect that all the schemes proposed by companies would be similarly efficient. AFW is not unique in this regard, as nearly every company has a similarly wide range of efficiency scores at the scheme level.

Moreover, the regression outputs are significantly influenced by individual schemes. In the absence of refining the model specification through additional normalisation factors, aggregating the results to the company level can mitigate misspecification errors and risks to some extent, assuming that there are no systematic biases in the assessment of costs and that each company has a sufficient number of schemes such that this 'noise' cancels out on average.[10]

While Ofwat has aggregated results to the company level, the aggregation approach needs to be aligned with the underlying regression sample, especially where we are dealing with a small and heterogenous dataset. This is particularly problematic for AFW, which has only one supply interconnector scheme, as the misspecification errors in its estimation are not offset through aggregation with other interconnector schemes that are reallocated prior to aggregation. AFW is estimated to be inefficient on this single scheme by £26.05m, but more efficient than the benchmark on its other schemes by £75.9m.[11] That is, while AFW's 'package' of schemes is assessed to be efficient 'in the round', Ofwat's failure to aggregate the results correctly results in a large, artificial efficiency gap (see Appendix A3).

More generally, as each scheme included in the regression model influences the regression coefficients, not aggregating schemes consistently at the company level leads to distortions in the efficiency

[10] Given the heterogeneity across the schemes, an individual scheme's performance in the models can be driven—to a large extent—by modelling errors (e.g. the omission of project-specific drivers). Assuming that these modelling errors are sufficiently random and that there are no company-specific biases, aggregating many schemes for each company could result in an unbiased assessment of costs. That is, the aggregation to the company level could mitigate companies' overall exposure to modelling risk (see Appendix A2).
[11] For the three other AFW schemes—Harefield to Harrow (62.93%), Heronsgate to Bovington (59.76%) and WRZ3 (40.13%)—efficiency scores were calculated using TOTEX over triangulated model predictions.

estimation. Thus, Ofwat should retain all the 32 forecast schemes at the aggregation step even if it subsequently reallocates some of these to other enhancement categories.

Inconsistent consideration of TOTEX spend

Ofwat models the full TOTEX of a scheme against the total proposed length and benefit, in order to maintain the cost–output relationship. In calculating the company-level efficiencies, Ofwat adjusts the submitted TOTEX to the proportion of spend that companies will incur in AMP8. This correction is applied prior to the calculation of bias correction and the average benchmark (see below), resulting in an inconsistent treatment of the scheme costs in the regression modelling and post-modelling adjustments. As noted above, Ofwat should retain a consistent sample of schemes at the various estimation steps in order to avoid inducing errors and biases in the efficiency estimation, and make any necessary adjustments ex post.

Incorrect calculation of the log bias

As Ofwat has noted, modelling data in logarithms and transforming them back to levels can result in a downward bias in the model predictions. In the current context, the bias is particularly severe at c. 20%.[12] We note that the Competition and Markets Authority (CMA) explored the log correction bias at the PR19 redetermination[13] and found that the bias was immaterial in practice on base costs. Therefore, the sheer magnitude of this bias in the current case may require further investigation (it may be driven by poor underlying model quality).

While Ofwat has performed a bias correction to account for this, the correction is insufficient to address the bias in the models and is applied inconsistently between the two models, as follows.

- **Historical data**. Ofwat estimates the bias correction based solely on outturn data. As such, it does not fully account for the biases and errors associated with extrapolating these models to assess future costs (the ultimate purpose of Ofwat's assessment). It is the *overall bias* in the estimation of the

[12] See Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final report', March, pp. 185–190.

[13] Competition and Markets Authority (2021), 'Anglian Water Services Limited, Bristol Water plc, Northumbrian Water Limited and Yorkshire Water Services Limited price determinations: Final report', March, paras 4.294–4.310.

forecast schemes that needs to be addressed and not the bias in the estimation of the historical schemes alone.

- **Forecast data**. Ofwat excludes a subset of schemes when calculating the bias correction. As noted above, consistent with the data used in the estimation, the bias correction should be based on all 32 schemes included in the estimation process and before any adjustment to TOTEX.

That is, using a subset of the modelled data to calculate bias, or ignoring the bias in the out-of-sample forecasting using historical data, results in incorrect or insufficient bias correction.

To ensure consistency in the estimation approach, we recommend three changes to Ofwat's approach:

- the full sample of 32 forecast schemes should be included when estimating company-specific efficiencies;
- the AMP8 adjustment and reallocation of the non-supply interconnector schemes should be considered after the efficiency assessment;
- the bias correction should cover the full sample of 32 forecast schemes, and should correct for the bias in the assessment of those forecast schemes (be it from historical or forecast schemes). This correction can be undertaken after triangulation of the predicted costs from the historic and forecast models (using Ofwat's equal weighting).

The impact of these errors on AFW's cost allowance is material, as shown in Table 1. Following our recommendations, AFW's company-level efficiency under Ofwat's model improves to 66.30% (i.e. its requested costs are efficient under an average benchmark). As its estimated efficiency is 161.60% under Ofwat's approach, this constitutes an improvement of 95%. Our proposed methodology is presented in full in Appendix A3.

Table 1 Difference in company-level efficiency under consistent modelling and under Ofwat's approach

	Consistent approach			Ofwat's approach			
Company	Requested TOTEX (£m)	Triangulated predicted costs (£m)	Efficiency	Requested TOTEX (£m)	Triangulated predicted costs (£m)	Efficiency	Difference
AFW	156.30	235.76	66.30%	68.62	42.46	161.60%	-95.31%

Note: Efficiency is defined as the ratio of requested to triangulated prediction costs (after bias correction).
Source: Oxera analysis.

Most companies' performances are not materially affected by our proposed improvements to Ofwat's modelling, as the difference between our approach and Ofwat's approach is between -1.39% and 4.44%, which, in the context of the underlying uncertainty in Ofwat's modelling, is marginal. However, the impact on AFW is highly material: following our recommendations, AFW's company-level efficiency under Ofwat's model improves to 66.30% (i.e. its requested costs are efficient under an average benchmark), an improvement of 95%. While AFW is estimated to be the least efficient company under Ofwat's modelling approach, it is estimated to be the frontier company under this improved framework.

Errors driven by a lack of appropriate normalisation of schemes

Our recommended approach to the company-level aggregation of scheme-level results can mitigate, to some extent, the challenges and biases that arise from Ofwat's simple model specification. As noted, significant differences in estimated scheme-level efficiency under Ofwat's model (between 29% and 245%) cannot be realistically and entirely linked to the inefficiency of the proposed schemes. Our review of AFW's Egham and Iver scheme indicates that much of this variance stems from complexity or unique project features that are not omitted in Ofwat's model and are therefore misidentified as inefficiency.

Based on information shared by AFW, we understand that the complexity of the interconnector schemes that determines the project costs can be defined in terms of the following.

- **Urbanity**: classification of areas based on their level of urban development and characteristics. Regions are classified into rural, suburban and urban settings, each of which reflects different costs depending on population density, infrastructure complexity and development level. Density drives costs mainly due to network disruption and third-party agreements.[14]

- **Surface type**: terrain or ground cover where the trunk renewals are being carried out. This can include the following categories: field, verge, footway, local roads, main roads/highways, water bodies, and building. Each surface type presents its own challenges and costs for infrastructure work (such as tunnelling), which affects the overall costs of the interconnector projects.
- **Major crossings**: major roads/highways and railway crossings that the project needs to navigate.
- **Diameter**: diameter of the pipes. Wider pipes can indicate more complex designs (such as in terms of material selection), and can be linked to surface type and urbanity in some cases, as wider pipes are more likely to be used in certain environments.

Ofwat neither accounts for these cost drivers explicitly nor considers the complex interrelationships between them. Based on costing information provided by AFW, we show that reasonable normalisation of the Egham and Iver scheme's costs for these complexities results in the scheme being estimated to be efficient on Ofwat's model and under an average benchmark. We have based our assessment on AFW's costing data, as we do not have access to similar data on all the proposed supply schemes. It should be possible for Ofwat to seek additional information on the other schemes in order to further validate the results of our proposed normalisation.

Identification of complexity attributes

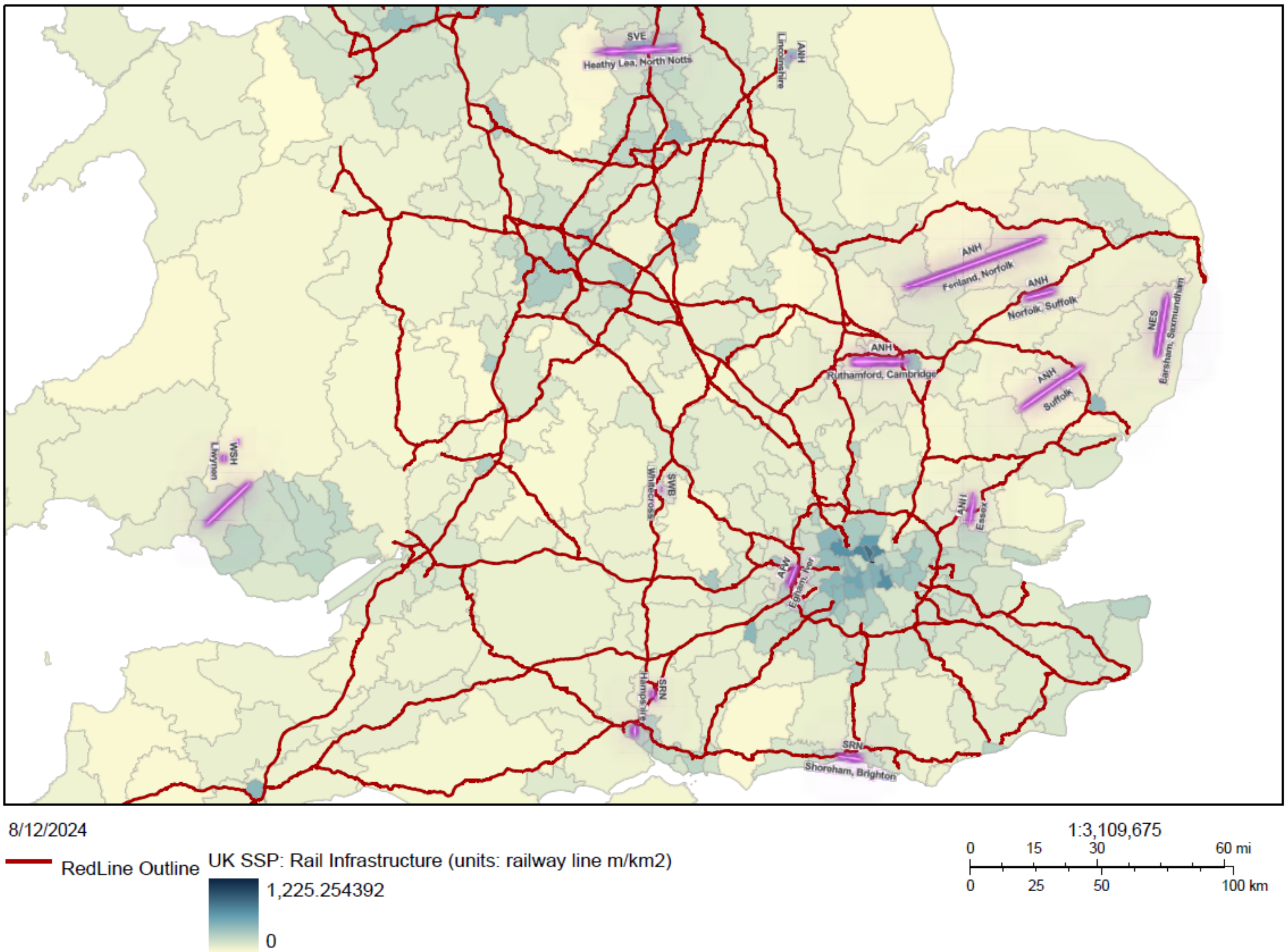
As noted, complexity in the interconnector schemes is driven by urbanity, surface type and pipe diameter, where pipe diameter can be determined by the other two factors.[15] Moreover, laying interconnector pipes through heavily urbanised areas such as the Egham and Iver route, which includes the M1 crossing and Wembley railway crossing, causes routing challenges and associated costs (for example, in terms of materials, tunnelling depth and network disruption).

[14] Urbanity is referred to as 'urbanicity' in AFW's project costing documentation and optioneering tool.
[15] A detailed description of each complexity factor can be found in Appendix A4.

Using data from the Met Office, UK SSP Rail Infrastructure and National Highways,[16] we have mapped the approximate location of the proposed supply interconnectors across England and Wales. Figure 1 shows the approximate location of the 18 forecast supply interconnector schemes based on the scheme's described route and using the central location of the starting and end regions that each scheme connects. The regions with darker blue have higher railway line density, and the red lines demarcate the UK highway system.

[16] Met Office data, UK SSP Rail Infrastructure (units m/km^2) is a spatial dataset used in climate impact and risk modelling—particularly for rail infrastructure in the UK under different Shared Socioeconomic Pathways (SSPs) scenarios. Highway Boundary RedLine data is a detailed map of the legal boundaries of highways. The mapping software used to create the visualisation of the 18 schemes is ArcGIS Pro developed by Environmental Systems Research Institute.

Figure 1 Map of rail density, highways and position of interconnector schemes



Note: AFW's Egham and Iver scheme is located on the western outskirts of London.
Source: Oxera analysis of Met Office data, UK SSP Rail Infrastructure (units m/km^2) and Highway Boundary RedLine data.

The Egham and Iver scheme sits to the west of London in a region with the highest railway line density and greatest number of highway intersections—the scheme sits in a congregation of dark blue (i.e. high rail infrastructure density) and red lines (i.e. higher intersections). Therefore, to enable a like-for-like comparison under Ofwat's simple model, it is necessary to normalise the unit costs according to the surface type and urbanity. Based on discussions with AFW engineers, we understand that most companies prioritise construction on less complex surface types, such as verges, over more challenging surfaces like the major carriageways found at Egham and Iver. The geospatial analysis depicted in Figure 1 substantiates this observation, offering a macro-level view that highlights a concentration of schemes in areas with fewer major carriageways and less dense rail networks where the crossings are associated with significant mitigation costs. For this reason, we consider that the costs of the Egham and Iver scheme should be normalised for less complex surface types to make it comparable to other schemes.

Proposed normalisation approach

We first normalise for differences in pipeline diameter, since the average diameter of the proposed supply interconnector schemes is 496mm, which is considerably less than the 700mm diameter in the AFW Egham and Iver scheme. Data shared by AFW (see Table 2 below) shows that a narrower pipeline diameter contributes to a lower pipeline unit cost regardless of surface type. This normalisation is therefore essential, which also helps to capture the cost of the pipeline material as that could be correlated with pipeline diameter.

Table 2 Average unit costs for less complex surface types relative to Egham and Iver

Urbanity	**Lower-upper nominal diameter (mm)**	**Surface type**	**Unit costs (£/m)**
Suburban, Egham and Iver	650–750	Local roads	£3,601
Rural urbanity, average of less complex surface types	475–650	Field, verge, footway, local roads, main roads	£1,802
Suburban urbanity, average of less complex surface types	475–650	Field, verge, footway, local roads, main roads	£1,984

Source: Oxera transformation of raw data provided by AFW from the AI optioneering tool used to generate unit costs.

Based on our geospatial analysis using public domain data depicted at Figure 1, and discussions with AFW, and in the absence of detailed information about the specific surface types of the various schemes, we use the average unit costs of the less complex surface types (i.e. avoiding buildings and water surfaces) provided by AFW to normalise the TOTEX of the Egham and Iver scheme. As noted above, we understand that companies tend to avoid crossings, buildings and water surfaces where possible, making it less likely that other schemes dealt with this level of complexity in a substantial manner. While we learned from AFW's engineers that most companies prefer to build on the verge surface type (i.e. the least complex surface type), as we do not have necessary information on the other schemes, as a conservative assumption, we take the average of unit costs across the less complex surface types to normalise Egham and Iver costs.

Our unit cost normalisation adjusts for the following factors:

- **diameter**: we considered unit costs based on a diameter range of 475–650mm, as this is most comparable to the other schemes;[17]
- **rural urbanity** and **less complex surface types**: within the specific diameter range, under the first normalisation approach, we took the average unit cost across the less complex surface types (i.e. field, verge, footway, main roads/highways and local roads) for rural urbanity;
- **suburban urbanity** and **less complex surface types**: within the specific diameter range, under the second normalisation approach, we took the average unit cost across the less complex surface types for suburban urbanity.

The route of the Egham and Iver scheme requires four major rail crossings and four major road crossings to be navigated, including the Wembley railway crossing and the M1, one of the busiest motorways in the UK. Crossing a major motorway incurs significant costs: to minimise operational disruption to a high volume of traffic; and, from an engineering perspective, to lay the pipeline deep enough to avoid interference with the road surface and withstand the loads from heavy traffic.

For the normalisation for crossings, as a conservative assumption, we assume that other interconnector schemes have to deal with at most one scheme of similar severity to the Egham and Iver scheme.

[17] The diameter of the pipes may be implicitly captured by the benefit of the scheme. To explore this further, as a sensitivity, we considered adjusting the benefit for the Egham and Iver scheme in line with the reduced diameter. The scheme is broadly efficient under this sensitivity (slightly more efficient under the rural urbanity normalisation and slightly less efficient under the suburban urbanity normalisation). Given the complex relationship between diameter and benefit, the conservative nature of the other normalisations considered, we treat this only as a sensitivity, the results of which are broadly aligned with the overall conclusion on the efficiency of the Egham and Iver scheme.

Impact of our proposed normalisation approach

Table 3 shows how the Egham and Iver scheme performs once the costs have been normalised for diameter, urbanity, surface types and major crossings. The first three columns take Ofwat's efficient cost prediction for the scheme as given (i.e. we do not re-estimate Ofwat's model), and only adjust the 'modelled cost' of the scheme on the basis of the normalisation factors outlined above. The second three columns re-estimate Ofwat's model with the adjusted costs for the Egham and Iver scheme.[18]

Table 3 Impact of normalisation of unit costs and major crossings

	Cost estimation using Ofwat's model			Cost estimation using re-estimated model and after triangulation log-bias correction		
Cost estimation basis	**Modelled costs**	**Efficient costs**	**Gap**	**Modelled costs**	**Efficient costs**	**Gap**
Actual costs	£68.62m	£42.46m	£26.16m	–	–	–
Normalised for rural urbanity, less complex surface types	£35.26m	£42.46m	-£7.2m	£35.26m	£41.02m	-£5.76m
Normalised for suburban urbanity, less complex surface types	£37.38m	£42.46m	-£5.08m	£37.38m	£41.08m	-£3.70m

Note: The efficient costs reported are triangulated, bias corrected and aggregated as per the approach outlined earlier in this report.
Source: Oxera analysis based on Ofwat's DD supply interconnector dataset and AFW's index unit costs (475–650mm unit trunks).

The table shows that the Egham and Iver scheme is assessed to be efficient in Ofwat's models once the omitted factors are accounted for. This finding highlights a critical oversight in Ofwat's modelling approach: the omission of complexity factors leads to a skewed perception of inefficiency, failing to reflect the underlying heterogeneity and cost dynamics inherent in the costing of such projects.

[18] For both rural and suburban models, coefficients are significant and positive, and the adjusted R squared slightly outperforms the Ofwat model.

Should Ofwat rely on its simple model in the FD, we recommend that it applies appropriate normalisation for unit costs and major crossings for the Egham and Iver scheme. Ofwat can validate information on the unit costs and crossings from AFW’s PR24 business plan and additional assurance provided as part of its response to the PR24 DDs, which it can further validate by requesting relevant data from other companies.

A1 Overview of AFW's Connect 2050 Enhancement programme

AFW's business plan assesses how its supply network will cope with the water resource challenges in the near to long term.[19] To respond to these challenges, AFW considers how to incorporate new sources of water from the Strategic Regional Options (SROs), how population growth changes current operations, and the impact of 'sustainability reductions' on moving water between existing demand centres (i.e. the impact of planned reductions in the amount of water that can be abstracted from natural water sources). The Connect 2050 project aims to capture the impact of both the new environmental destination and SRO requirements as an evolution of AFW's previous Supply 2040 project. AFW considers that the SROs are the only options that would provide the additional supplies needed to meet the supply–demand balance deficits, given the magnitude of the sustainability reductions.

Connect 2050 integrates AFW's WRMP, Resilience, and Water Industry National Environmental Programme (WINEP) strategies. As part of the WRMP, it ensures the supply to customers over the long term and therefore meets AFW's statutory obligations.[20] It also supports AFW's ambition for sustainable abstraction reductions under WINEP. Finally, Connect 2050 sets out to strengthen the resilience of water supply capabilities to the emerging risks of climate change and third-party impacts, by providing additional storage capacity.

The strategic aims of AFW's Connect 2050 project can be summarised as follows:

- increase the outputs of its Wey treatment works by 40 megalitres a day (Ml/d);
- transfer an additional 38Ml/d from Wey to the rest of the central region;
- improve strategic transfers by creating additional booster pumping stations and laying additional trunk mains interconnectors, to meet deficits at the local level;

[19] Affinity Water (2023), 'Affinity Water Connect 2050', September, pp. 946–947.
[20] Affinity Water (2023), 'Affinity Water Connect 2050', September, pp. 935–946.

- increase storage capacity. The resilience projects in AMP8 include the addition of 20Ml/d (total) of treated water storage, at two strategic locations.

The table below sets out the projects included in AFW's PR24 business plan. The four projects in bold are included in the interconnector schemes cost modelling.

Table A1.1 Connect 2050 WRMP and Resilience projects

Scheme name	**WRMP**	**WINEP sustainable reductions**	**Resilience**	**Main driver**
Increase DO Wey area	✓	✓	✓	WRMP
Egham and Iver interconnector	✓	✓	✓	WRMP
Midway North (Stanwell Moor) BPS upgrade	✓	✓	✓	WRMP
Watford to Heronsgate interconnector BPS transfer	✓	✓	✓	WRMP
Harefield to Harrow interconnector		✓	✓	WINEP SR
Heronsgate to Bovingdon		✓	✓	WINEP SR
Local Resilience scheme WRZ3		✓	✓	WINEP SR

Source: AFW business plan.

Note: BPS refers to Booster Pumping Station and SR refers to Service Reservoir.

Connect 2050 includes four supply interconnector schemes that are in line with AFW's WRMP, presented in Table A1.1. However, Ofwat excluded AFW's 'The Grove valve -Licence Re-Location BPS transfer' and 'Midway North BPS upgrade' schemes on the basis that AFW has stated a pipeline length of zero. With a view to augmenting the sample size, Ofwat included three WFD schemes that are part of AFW's WINEP SR. Therefore, AFW's assessed schemes under the interconnector supply model include the Egham and Iver supply interconnector scheme, along with the WFD Harefield to Harrow interconnector scheme, the WFD Heronsgate to Bovingdon scheme, and Local Resilience scheme WRZ3. Despite the inclusion of the WFD interconnector schemes in the model, they were funded through resilience after reallocation from the supply interconnector analysis.[21]

[21] Ofwat (2024), 'PR24 draft determinations: Expenditure allowances - Enhancement cost modelling appendix', July.

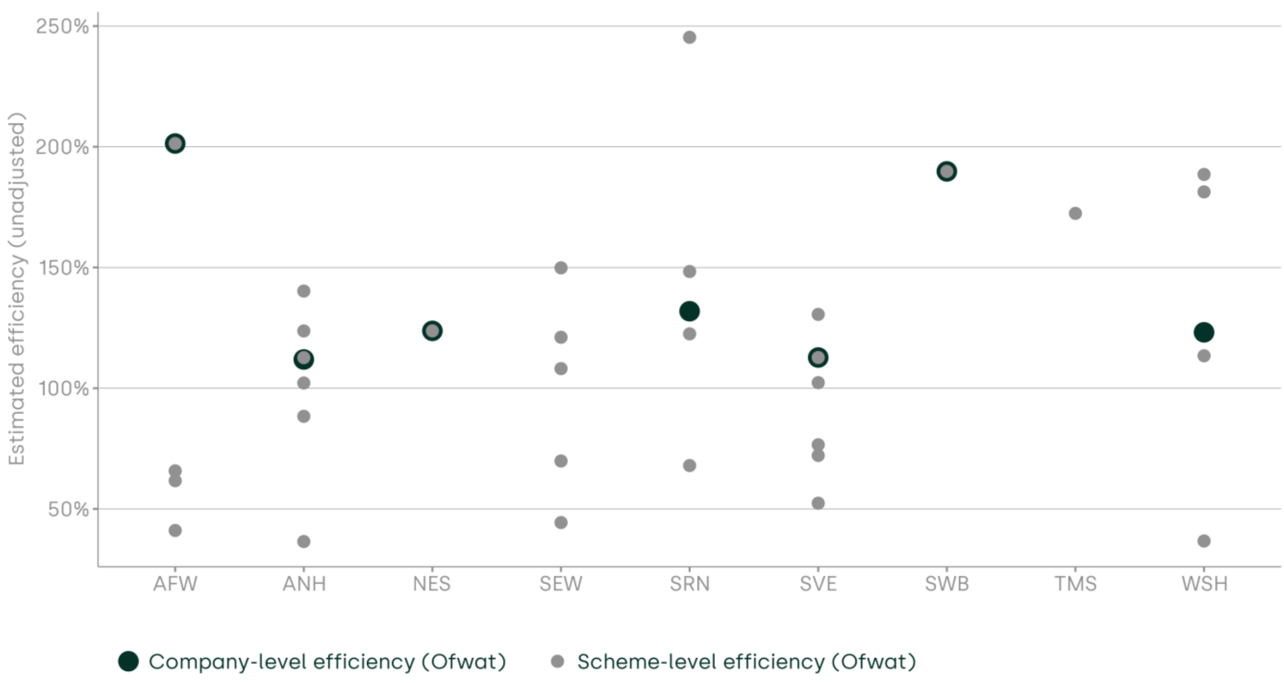
A2 Lack of comparability of interconnector schemes

Among the Ofwat-approved schemes, we observe that the investments are geographically dispersed and aimed at addressing region-specific needs. This results in a wide range of costs and project sizes.

The scale of individual projects may be captured through the scale variables in Ofwat's model (length and benefit). However, other regional factors—including urbanity, surface type, design complexities such as road/rail crossings and pipeline diameter—are not explicitly captured in the model. In the absence of appropriate pre- or post-modelling adjustments, the estimated efficiency of an individual scheme under Ofwat's model is likely to capture these project-specific drivers in addition to (or instead of) inefficiency.

To demonstrate this, the figure below presents the range of estimated efficiency scores for each company at the scheme level.

Figure A2.1 Scheme-level efficiency range (32 forecast schemes)



Note: Small grey dots represent scheme-level efficiency and large dark dots represent company-level efficiency under Ofwat's approach.

Source: Oxera analysis of Ofwat's DD Supply interconnector dataset.

If the models were capturing solely (or even largely) the efficiency of the projects, we would expect that the schemes for an individual company would have a similar level of estimated efficiency. However, the range of estimated efficiency scores within a company is often material to the extent of being unrealistic.

As shown in Figure 2.1, each company has at least two schemes that are materially less efficient than the others. We note that, for some companies, only one scheme is assessed to be significantly less efficient than the others—for example, AFW's Egham and Iver scheme. It is feasible that this is because most of the schemes proposed by the companies are broadly comparable once length and benefit are accounted for, and that there are a handful of schemes that suffer from more challenging operating environments and project requirements. In this context, Ofwat's model with an average benchmark might be reasonable for assessing the majority of schemes once aggregated to the company level, providing that there is a deep-dive assessment of schemes that are complex and assessed to be materially inefficient under their model.

A3 Inconsistent treatment of interconnector schemes

Ofwat compares the interconnector schemes—be they supply-, resilience-, DPC- or WFD-driven—on the basis that they are intended to reduce risk or to increase the amount of water available in the region, or both. Specifically, Ofwat deems the pipeline element of the various schemes to be comparable based on their proposed length and benefit relative to their TOTEX. However, Ofwat excludes the non-supply interconnectors (WFD, resilience and DPC) from the determination of the bias correction, benchmark and cost allowance, resulting in an arbitrary and inconsistent treatment of the different schemes. This approach is not justified by Ofwat in its DD documentation.

Ofwat's assessment is simplistic, as it encompasses schemes that differ manifestly by type, purpose and complexity but that are assumed to be comparable based solely on length and benefit. As such, Ofwat's model is unable to distinguish between schemes that are inefficient and those that are expensive due to their physical and engineering challenges. It assumes that all the differences between the model's cost predictions and requested costs are due to inefficiency, rather than scheme-specific characteristics.

The average company-wide benchmark approach that Ofwat has proposed is perhaps designed to account for the simplicity of its analysis (where, as noted, results vary significantly at the scheme level). Companies with more than one supply interconnector scheme benefit from errors and biases at the level of individual schemes being offset to some extent when results are aggregated to the company level. However, the negative bias embedded in Ofwat's assessment of AFW's Egham and Iver scheme (due to the omission of important factors, such as design complexity) is not offset by potential positive biases elsewhere, as AFW's other schemes are excluded from the aggregation process. Ofwat does not explain why it deems all types of interconnector scheme to be sufficiently comparable to be included in its models in the first place, but then does not retain the same set of schemes in the determination of the benchmark and overall cost allowance at the company level. This inconsistency renders Ofwat's conclusions unreliable in the case of AFW.

To avoid such errors and to follow a more consistent approach, we propose the following methodology to calculate cost efficiencies and allowances.

1 For requested TOTEX at the company level, use TOTEX without AMP8 corrections.
2 Using regression coefficients estimated from the historical and forecast models, compute the predicted modelled costs for the 32 forecast schemes, and compute their triangulated value.
3 Aggregate these predictions to the company level and compute the log bias correction as the ratio of the total unadjusted TOTEX to the total triangulated cost predictions including all 32 schemes.
4 Apply log-bias correction to the company predictions and consider any necessary post allocation (such as AMP8 adjustment or reallocation to another enhancement category).

The proposed sequence of steps and impact of these for AFW are presented in Table A3.1 below.

Table A3.1 Proposed sequence of steps under a consistent approach

	Requested TOTEX	Modelled allowances (historic, unadjusted)	Modelled allowances (forecast, unadjusted)	Modelled allowances (50/50, unadjusted)	Requested TOTEX/modelled allowance (triangulated)	Requested TOTEX/modelled allowance (triangulated, adjusted)	Adjusted allowance
AFW	156.30	205.41	192.47	198.94	78.56%	66.30%	235.76

Source: Oxera analysis.

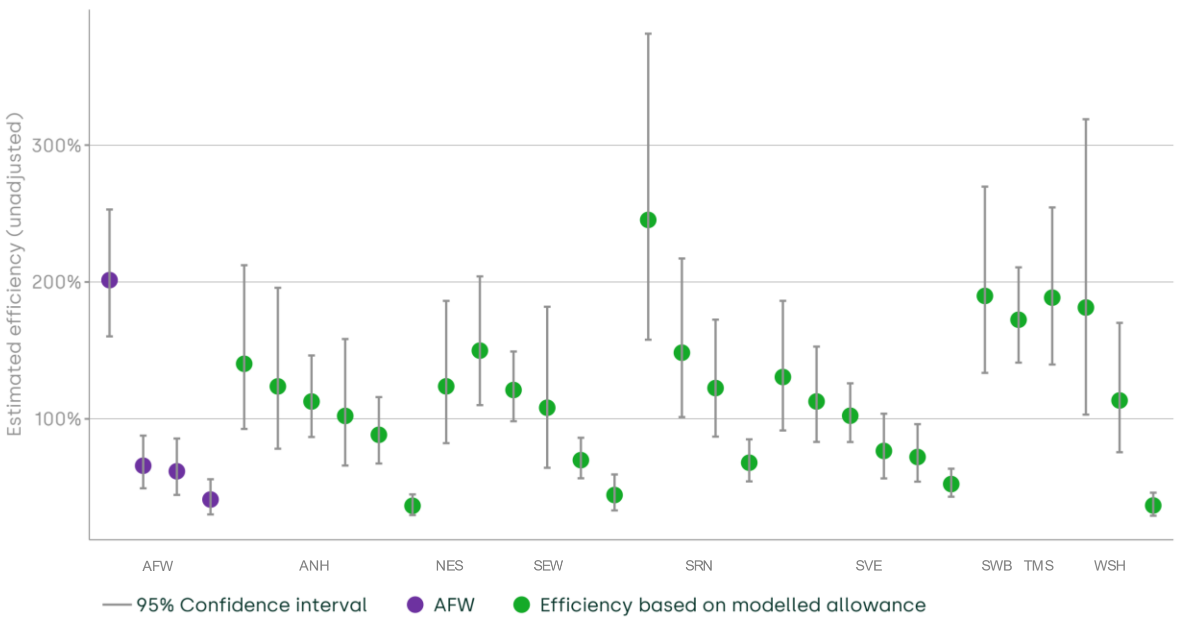
As shown in the table, even under Ofwat's current model (ignoring other limitations with it, such as a lack of suitable normalisation for Egham and Iver), at the company level, AFW's cost estimates across its schemes are more efficient than the average benchmark. This suggests that the issue is not AFW's overall efficiency in delivering interconnector projects, but rather the distinct and unique characteristics of a specific project that are not normalised in Ofwat's model or through the aggregation. The impact is not material for the rest of the sector in the context of general modelling uncertainty in Ofwat's models.

A4 Uncertainty in Ofwat's models

Given the limitations of the models (outlined in the above sections), we have explored the level of uncertainty in the models through confidence interval analysis. The width of the confidence interval around the predicted cost of a scheme is a direct measure of uncertainty, where the wider the confidence interval, the more uncertain the prediction (and thereby the model employed). This technique has been considered by regulators to inform the benchmark and was also investigated by the CMA in the PR19 redetermination.

The figure below shows the 95% confidence interval on the predicted costs of each scheme in Ofwat's models.

Figure A4.1 95% confidence intervals for scheme efficiency



Source: Oxera analysis on Ofwat's DD Supply IC dataset.

The width of the confidence intervals for certain schemes vary between c. 15.11% and c. 223.56%, revealing high uncertainty in modelled allowances. It is also evident that some companies' schemes are estimated with more uncertainty than others. Given the level of uncertainty in Ofwat's scheme-level modelling, it would be necessary to undertake a robust deep dive assessment, particularly for those schemes that are assessed to be materially inefficient.

A5 Proposed normalisation of the Egham and Iver scheme

Below is a description of the TOTEX calculation method applied by AFW to cost its Egham and Iver scheme.

First, CAPEX (capital expenditure) includes a 10% risk factor for the trunk main and a 20% risk factor for the Booster Pumping Station, which breaks down into 15% for risk and an additional 5% for Biodiversity Net Gain. This expenditure is planned for delivery in 2029 and includes one year of OPEX (operational expenditure) in the current AMP. Subsequently, AFW adds the CAPEX associated with increasing Deployable Output (DO) in the Wey area to the CAPEX for Egham, and this total is combined with the OPEX for Egham and Iver.

For the purpose of our analysis, we follow this formula to re-estimate the costs for our normalisation exercise, but we use the figures submitted to Ofwat when assessing the efficient costs in the report.

The adjustments below are for rural and suburban urbanity on less complex surface types and a diameter of 475–650mm.

Table A5.1 Calculation of TOTEX under different surface types

	Unit cost	Estimated cost of trunk main (£m)	Booster cost + trunk main (£m)	CAPEX (£m)	TOTEX (£m)
Rural, less complex surface types	£1,802.48	20.21	24.69	35.04	35.26
Suburban, less complex surface types	£1,984.14	22.14	26.62	37.17	37.38

Source: Oxera analysis of the calculation of TOTEX using unit costs obtained from AFW's optioneering tool.

The Egham and Iver scheme is based on the suburban local road surface type and diameter of 650–750mm.

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